

A fully Automatic Infrared Induction Cleaning Device for Public Toilets

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Abstract— In view of the hygienic condition and cleaning requirements of public toilets, a practical "automatic infrared induction toilet cleaning device" has been designed to change the cleaning method of cleaners to the bathroom, which can further reduce the workload of cleaners and saving water resources.

Index Terms— public toilet; water saving; infrared sensor; cleaning

I. INTRODUCTION

With the improvement of people's living standard, people's requirement for sanitary environment of toilet is also increased. A well-equipped and clean toilet can greatly improve the overall grade of a place. The trend is to use automated mechanical equipment to replace heavy human work. We study and analyze the hygienic conditions of public toilets in China, and then develop an infrared sensor-based automatic cleaning device that could be common applied to public toilets. With the help of this device, it would significantly improve the hygienic condition, reduce the workload of cleaners and reduce water waste.

II. THE STATUS OF MOST PUBLIC TOILET IN CHINA

Public toilets in places with high people flow, such as railway station, hospital, park, shopping mall etc., are overcrowded. This lead to high workload of the cleaners and sometimes make the cleaner unable to guarantee the sanitation. These public toilets are often dirty and their smell also impacts their surrounding environment.

According to the survey 《concern about the living conditions of front-line sanitation workers》 published by People's Daily shows: Cleaners in China, 70 years of age is not rare, 50~60 years old is common, and 40 years old has been considered young. Poverty、age, low level of education is the common characteristics of Chinese sanitation workers. They lack basic security in the working environment.

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How to keep the public toilet clean at any time to increase the satisfaction of the public and reduce the workload of the cleaners?

III. A FULLY AUTOMATIC INFRARED SENSOR CLEANING DEVICE FOR PUBLIC TOILET

A. The overall design concept

This cleaning device have two functions: automatic flushing function and can replace the cleaning workers in some cleaning work. It can not only save water, but also reduce the working pressure of cleaner. It will help to keep the toilet always in a good health condition.

The device can set the frequency of automatic cleaning according to the requirements of different places. Through the infrared sensor it can accurately and quickly clean toilet floor with less time the less water than manual cleaning.

B. Main structure of the cleaning device

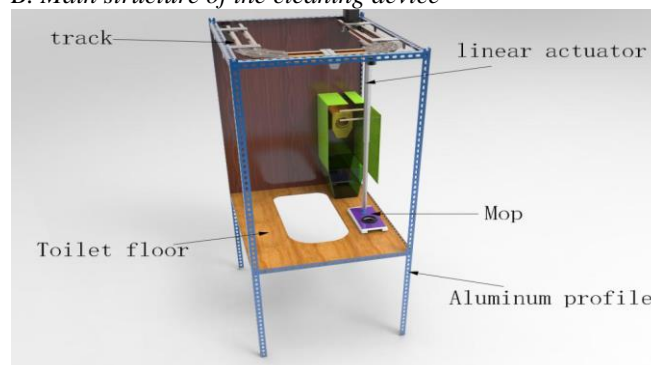


Figure 1 Model of cleaning device at working status.

Figure 1 is the conceptual model of this device with scale 1:2 at working status. The space surrounded by aluminum is a compartment in public toilet. Cleaning mop is connected with a linear actuator which mounted at the top track. The actuator can move back and forth along the track driven by the pulley and the belt, and hence make the mop realize the cleaning action on the floor.

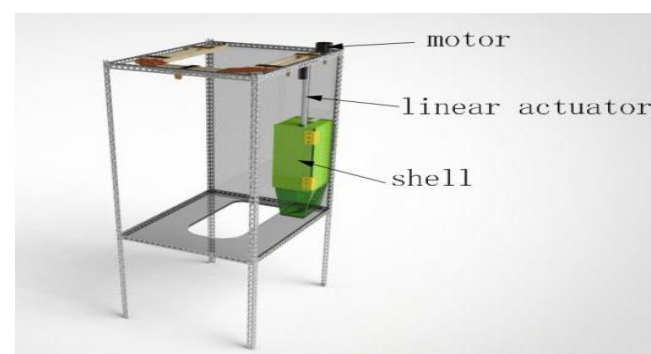


Fig. 2 Device at non-working status

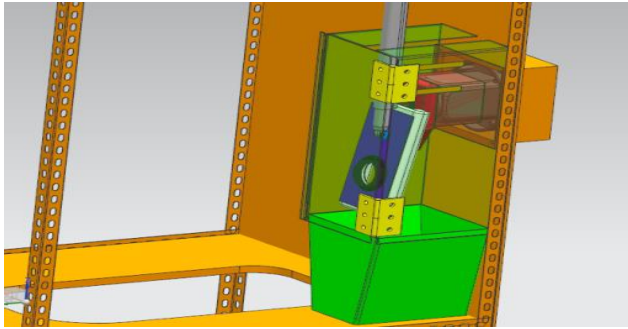


Fig. 3 Device at non-working status.

Figure 2 and figure 3 show the device at non-working status. When the device senses that the toilet is in use (someone in the compartment), the motor will be automatically cut off, the linear actuator move back to the original position, and the mop back to the shell.

C. Transmission mechanism of the cleaning device.

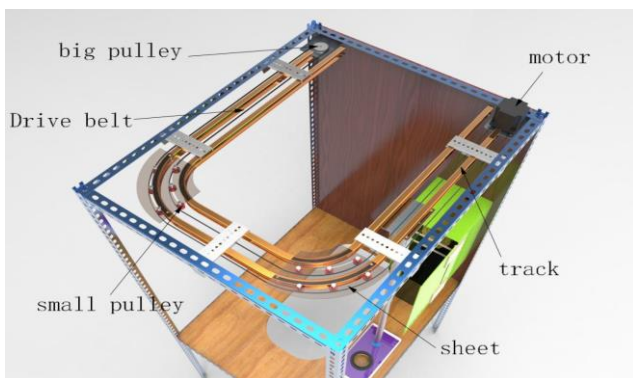


Figure 4 The top of the device

Figure 4 is the overall transmission mechanism on the top of the device, mainly by track, big pulley, small pulley, sheet, belt and motor.

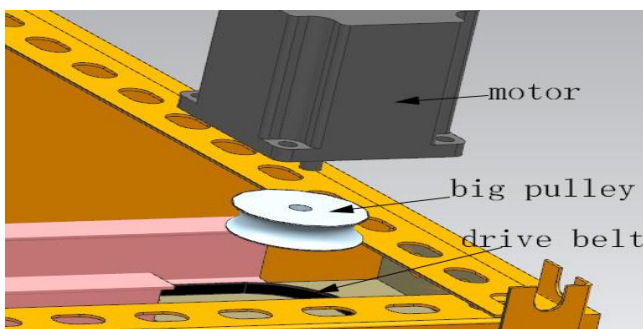


Fig. 5 Motor at the end of track

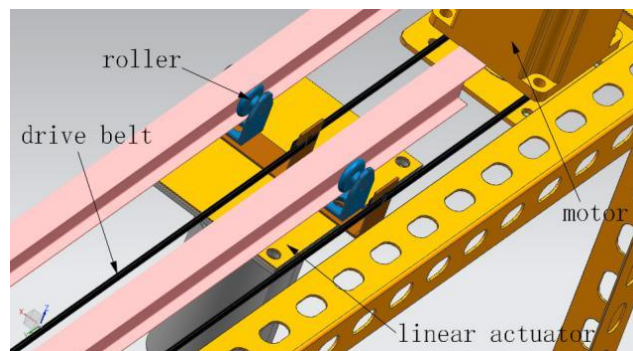


Fig. 6 The connection of belt and actuator.

The big pulley is connected to the shaft of the motor (see Fig. 5). When the motor is energized, it drives the big pulley and the belt on the big pulley. The belt is connected with the top of the linear actuator (see Fig.6). When the belt rotates, the linear actuator will be driven to move.

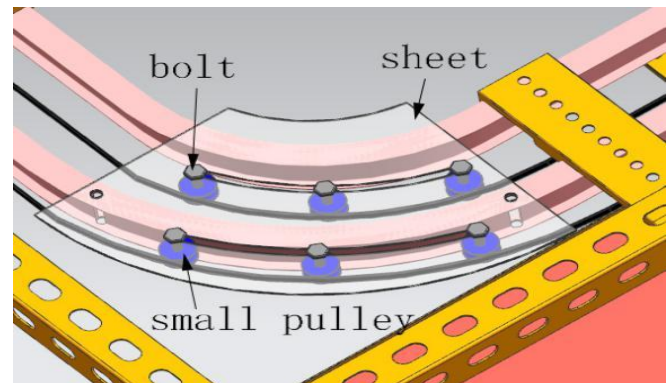


Fig. 7 sheet and small pulleys at the corner of the track

There are six small pulleys which are connected to the sheet by bolts and hence fixed at the corner of the track (see Fig.7). These six small pulleys avoid the belt contacted too tight with track at the corner, which will lead to belt unable to rotate due to high.

D. Shell of the cleaning device

When the device doesn't work, the mop will stay in the green shell (see Fig.8). The door is connected with the shell by the magnetic force. When the device starts to work, the linear actuator moves forward while stretches, pushes the door open (Fig.9). When the linear actuator moves to the other end of the track, motor reverse and drive the linear actuator back to the front of shell. The linear actuator shrinks at this position and pushes the lever on the door which drives the door closed, the device back to the initial state (Figure 8) at the end

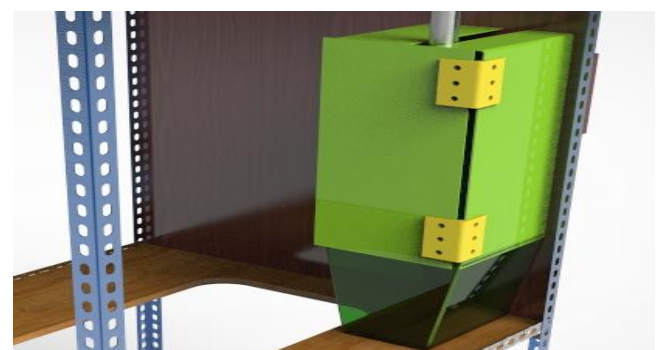


Fig. 8 Shell (closed)

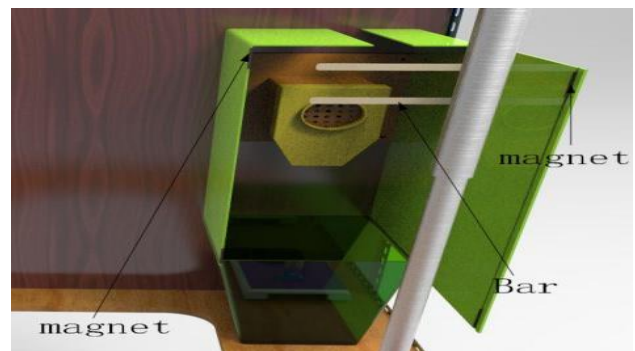


Fig. 9 Shell (open)

The shell not only protects the device, but also has a beautiful and practical function. When someone uses the toilet, the personal articles can be placed on it.

E. Dust absorbing structure of the cleaning device

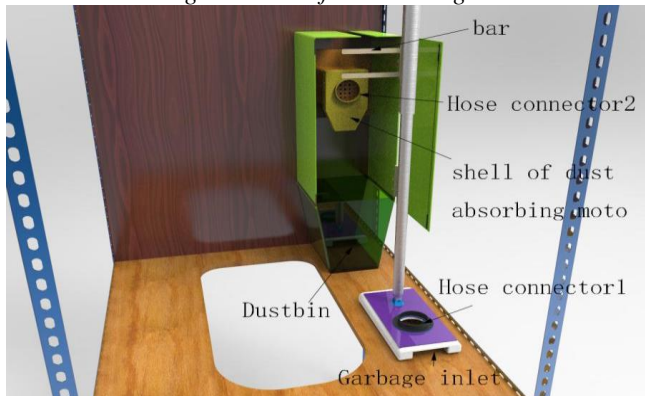


Fig. 10 Dust absorbing structure of the device.



Fig. 11 Flexible hose

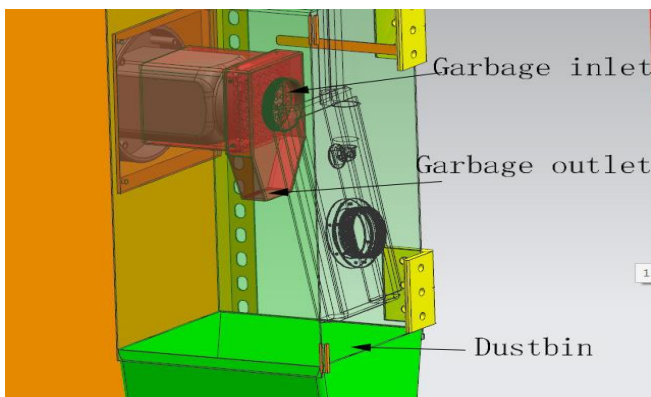


Fig. 12 Perspective view of motor shell

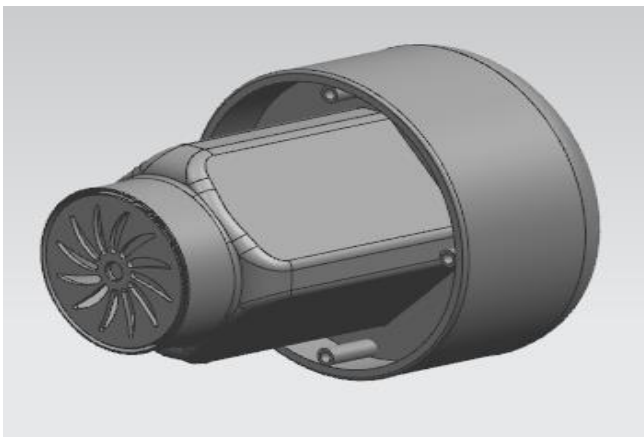


Fig. 13 vacuum motor

Since people often throw rubbish in the compartment, so the device equipped with a vacuum motor in the shell. A hose is equipped which can be mounted between mop and the vacuum motor in the shell (see Fig.10~13).

When the device is at work, the vacuum motor is powered on and generates a strong suction which draws the garbage around the mop through the garbage inlet on the mop and the hose into the vacuum motor shell, and then fall into the garbage collection box through the opening under the shell of the vacuum motor.

IV. CONCLUSIONS

The device aims at saving resources, not only saving water resources but also saving human resources. Many cleaners like to use many buckets of water to rinse toilet during manual work, which leads to a great waste of water resources. If apply this device, only a small amount of water can achieve a cleaning effect, it saves a lot of water. The device integrates automatic flushing together. It does not require human's intervention and greatly reduces the workload of cleaners.

REFERENCE

- [1]Ding ye.Emotional Communal Toilet Facilities of Megastore(D).Beijing : Beijing Forestry University.2007
- [2]Cui Wei.The Design of Public Toilet Facilities (J).Chinese Businessman , 2008 (15) : 168-169
- [3]Shi Huixian.On Humanized Design Of Public Toilet(D).Dalian : Dalian Polytechnic University.2013
- [4]Wang Xiaohang.Discussion On The Design Of New City Mobile Public Toilet (J) .Idea & Design , 2016 (2) :47-52
- [5]Ma Ying , Chen Shu , Li Jiao.Human Nature Analysis Of PublicToilet In Chengdu Subway Station (J) .Journal of Luzhou Vocational Technical College , 2012 (4) : 68-72
- [6]Ma Guangtao , Zhen Shiming.Research And Analysis Of The Public Toilet Facilities System On Ergonomics (J) .Design , 2015 (15) : 136-137
- [7]Yang Xun,Li Zhen, Zeng Shan.Facilities Are Not Complete Bathroom Has Become The Soft Underbelly Of Shopping Services(N).Beijing daily , 2007-11-05
- [8]Qing Mei.Toilet Design In The Large Retail Commercial Buildings(D).Xian,Xi'an University Of Architecture And Technology.2014
- [9]Zhang Ruifeng , Chen Zhuangzhuang , Cui Yu.Discussion On The Design Of Modern Public Toilet (J) .Modern Decoration , 2015 (5) :64-64

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